Record 1 of 47

Author(s): Fitch, JE (Fitch, Jayne E.); Crowe, TP (Crowe, Tasman P.)

Title: Effective methods for assessing ecological quality in intertidal soft-sediment habitats

Source: MARINE POLLUTION BULLETIN, 60 (10): 1726-1733 OCT 2010

Abstract: Impacts of anthropogenic pollution on marine ecosystems are being addressed by legislation to protect and restore coastal and transitional waters. A range of biological measures have been investigated for their ability to indicate anthropogenic disturbance in subtidal soft-sediment habitats, but little work to date has focussed in intertidal habitats. This study investigated the sensitivity of communities, individual taxa, diversity indices and biotic indices to nutrient and organic enrichment in intertidal soft-sediment habitats. Variation in macrofaunal communities was more strongly associated with anthropogenic stressors than with natural environmental variation. Two multimetric indices, M-AMBI and IQI, were more closely associated with nutrient and organic pollution than the AMBI and ITI indices. Intertidal monitoring based on existing monitoring tools offers a cost effective alternative to subtidal monitoring and has potential to form the basis for an ecosystem level approach.

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DOI: 10.1016/j.marpolbul.2010.06.027

Record 2 of 47

Author(s): Parravicini, V (Parravicini, Valeriano); Thrush, SF (Thrush, Simon F.); Chiantore, M (Chiantore, Mariachiara); Morri, C (Morri, Carla); Croci, C (Croci, Camilla); Bianchi, CN (Bianchi, Carlo Nike)

Title: The legacy of past disturbance: Chronic angling impairs long-term recovery of marine epibenthic communities from acute date-mussel harvesting

Source: BIOLOGICAL CONSERVATION, 143 (11): 2435-2440 NOV 2010

Abstract: Two major concerns affect the way we perceive impacts: first, no ecosystem can still be considered pristine and second, stressors may interact. Untangling the effects of broad-scale anthropogenic stressors is complicated as appropriate unimpacted areas at relevant scales are usually unavailable for contrast with impacted regions. Although the perfect study design in the traditions of small-scale manipulative experiments may not always be possible, many human impacts and the mechanisms associated with ecosystem responses have been highlighted in literature allowing contrasting predictions on expected patterns to be tested. We applied such an approach to the Marine Protected Area of Bergeggi (Ligurian Sea, NW Mediterranean). Our study aimed at assessing the effects of recreational angling (a presumed chronic stress) on the recovery of epibenthic communities following historical date-mussel harvesting (an extreme disturbance) by making and testing alternative predictions on the structure of epibenthic communities that should be apparent depending on the importance of specific mechanisms. Effects of date-mussel harvesting were still visible 20 years after its cessation, mostly because recovery is hampered by persistent sea-urchin grazing. We hypothesized that fish biomass removal by angling favours high sea urchin abundance. Based on these premises, we assembled information on angling pressure, sea urchin abundance and substratum cover by different trophic guilds to test our predictions. Our study indicates that the interaction between date-mussel harvesting and angling produced a shift, from autotrophic-dominated to consumer-dominated communities as a consequence of cascading trophic effects. Such an outcome implies that chronic recreation fishing pressure is blocking recovery in locations previously impacted by date-mussel harvesting. Testing predictions proved efficient in describing the interaction among stressors when system history is known and represents a valuable approach to provide scientifically sound insight for improved conservation management.

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Record 3 of 47

Author(s): Blake, RE (Blake, Rachael E.); Duffy, JE (Duffy, J. Emmett)

Title: Grazer diversity affects resistance to multiple stressors in an experimental seagrass ecosystem

Source: OIKOS, 119 (10): 1625-1635 OCT 2010

Abstract: When multiple stressors act simultaneously, their effects on ecosystems become more difficult to predict. In the face of multiple stressors, diverse ecosystems may be more stable if species respond differently to stressors or if functionally similar species can compensate for stressor effects on focal species. Many habitats around the globe are threatened by multiple stressors, including highly productive seagrass habitats. For example, in Chesapeake Bay, USA, regional climate change predictions suggest that elevated temperature and freshwater inputs are likely to be increasingly important stressors. Using seagrass mesocosms as a model system, we tested whether species richness of crustacean grazers buffers ecosystem properties against the impacts of elevated temperature and freshwater pulse stressors in a fully factorial experiment. Grazer species responded to pulsed salinity changes differently; abundance of Elasmopus levis responded negatively to freshwater pulses, whereas abundance of Gammarus mucronatus and Erichsonella attenuata responded positively or neutrally. Consistent with the hypothesis that biodiversity provides resistance stability, biomass of epiphytic algae that form the base of the food web was less affected by stressors in species-rich grazer treatments than in single-species grazer treatments. Stochastic (among-replicate) variation of sessile invertebrate biomass within treatments was also reduced in more diverse grazer treatments. Therefore, grazer species richness tended to increase the resistance stability of both major components of the seagrass fouling community, algae and invertebrates, in the face of environmental stressors. Finally, in our model system, multi-stressor impacts suggested a pattern of antagonism contrary to previous assumptions of synergistic stressor effects. Overall, our results confirm that invertebrate grazer species are functionally diverse in their response to environmental stressors, but are largely functionally redundant in their grazing effects leading to greater resistance stability of certain ecosystem properties in diverse grazer assemblages even when influenced by multiple environmental stressors.

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DOI: 10.1111/j.1600-0706.2010.18419.x

Record 4 of 47

Author(s): Fischer, BB (Fischer, Beat B.); Rufenacht, K (Ruefenacht, Karin); Dannenhauer, K (Dannenhauer, Kerstin); Wiesendanger, M (Wiesendanger, Manuela); Eggen, RIL (Eggen, Rik I. L.)

Title: MULTIPLE STRESSOR EFFECTS OF HIGH LIGHT IRRADIANCE AND PHOTOSYNTHETIC HERBICIDES ON GROWTH AND SURVIVAL OF THE GREEN ALGA CHLAMYDOMONAS REINHARDTII

Source: ENVIRONMENTAL TOXICOLOGY AND CHEMISTRY, 29 (10): 2211-2219 OCT 2010

Abstract: Exposure of the green alga Chlamydomonas reinhardtii Dangeard to a combination of environmental stress by high light irradiance and chemical stress by each of the three herbicides paraquat, atrazine, and norflurazon resulted in diverse multiple stressor effects on growth and survival of the cells. Under low light conditions, growth analyzed by cell numbers was generally more sensitive to herbicide treatment than optical density based growth rates or colony-forming unit endpoints, which both also analyzed the viability of the cells. However, growth analyzed by optical density and colony-forming units in herbicide-treated cultures was affected much more strongly by high light irradiance, as shown by reduced 50% effective concentrations, indicating extensive multiple stressor effects of the combined treatment on the viability of the cells. None of the currently used concepts for mixture toxicity (concentration addition, independent action, or effect summation) could accurately describe the effects measured by the two stressors in combination. Both synergistic and antagonistic interactions seem to occur depending on the light conditions and the parameter analyzed.

The strong stimulation of toxicity by the combined stresses can be explained by the similar mode of toxic action of the treatments, all increasing the production of reactive oxygen species. Antagonistic effects, conversely, are probably attributable to the various protection mechanisms of photosynthetic organisms to increased light irradiance, which help the cells acclimate to specific light conditions and defend against the deleterious effects of excess light. These protection mechanisms can affect growth and viability under increased light conditions and also might influence the toxicity of the photosynthetic herbicides. Environ. Toxicol. Chem. 2010;29:2211-2219. (C) 2010 SETAC

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DOI: 10.1002/etc.264

Record 5 of 47

Author(s): Molinos, JG (Molinos, Jorge Garcia); Donohue, I (Donohue, Ian)

Title: Interactions among temporal patterns determine the effects of multiple stressors

Source: ECOLOGICAL APPLICATIONS, 20 (7): 1794-1800 OCT 2010

Abstract: Recent research has revealed that one of the most important characteristics of both natural and anthropogenic disturbances is their temporal heterogeneity. However, little is known about the relative importance of interactions among temporal patterns of multiple stressors. We established a fully factorial field experiment to test whether interactions among temporal patterns of two globally important anthropogenic disturbances of aquatic ecosystems (increased sediment loading and nutrient enrichment) determined the responses of stream benthic assemblages. Each disturbance treatment comprised three distinct regimes: regular and temporally variable pulses and an undisturbed control. The overall frequency, intensity and extent of disturbance was, however, equal across all disturbed treatments. We found that interactions among temporal disturbance regimes determined the effects of the compounded sediment and nutrient perturbations on algal biomass and the diversity, taxonomic and trophic composition of benthic assemblages. Moreover, our results also show that the temporal synchronization of multiple stressors does not necessarily maximize the impact of compounded perturbations. This comprises the first experimental evidence that interactions among the temporal patterns of disturbances drive the responses of ecosystems to multiple stressors. Knowledge of the temporal pattern of disturbances is therefore essential for the reliable prediction of impacts from, and effective management of, compounded perturbations.

ISSN: 1051-0761

Record 6 of 47

Author(s): Benedetti-Cecchi, L (Benedetti-Cecchi, Lisandro); Iken, K (Iken, Katrin); Konar, B (Konar, Brenda); Cruz-Motta, J (Cruz-Motta, Juan); Knowlton, A (Knowlton, Ann); Pohle, G (Pohle, Gerhard); Castelli, A (Castelli, Alberto); Tamburello, L (Tamburello, Laura); Mead, A (Mead, Angela); Trott, T (Trott, Tom); Miloslavich, P (Miloslavich, Patricia); Wong, M (Wong, Melisa); Shirayama, Y (Shirayama, Yoshihisa); Lardicci, C (Lardicci, Claudio); Palomo, G (Palomo, Gabriela); Maggi, E (Maggi, Elena)

Title: Spatial Relationships between Polychaete Assemblages and Environmental Variables over Broad Geographical Scales

Source: PLOS ONE, 5 (9): Art. No. e12946 SEP 23 2010

Abstract: This study examined spatial relationships between rocky shore polychaete assemblages and environmental variables over broad geographical scales, using a database compiled within the Census of Marine Life NaGISA (Natural Geography In Shore Areas) research program. The database consisted of abundance measures of polychaetes classified at the genus and family levels for 74 and 93 sites, respectively, from nine geographic regions. We tested the general hypothesis that the set of environmental variables emerging as potentially important drivers of variation in polychaete assemblages depend on the spatial scale considered. Through Moran's eigenvector maps we indentified three submodels reflecting spatial relationships among sampling sites at intercontinental (>10000 km), continental (1000-5000 km) and

regional (20-500 km) scales. Using redundancy analysis we found that most environmental variables contributed to explain a large and significant proportion of variation of the intercontinental submodel both for genera and families (54% and 53%, respectively). A subset of these variables, organic pollution, inorganic pollution, primary productivity and nutrient contamination was also significantly related to spatial variation at the continental scale, explaining 25% and 32% of the variance at the genus and family levels, respectively. These variables should therefore be preferably considered when forecasting large-scale spatial patterns of polychaete assemblages in relation to ongoing or predicted changes in environmental conditions. None of the variables considered in this study were significantly related to the regional submodel.

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DOI: 10.1371/journal.pone.0012946

Record 7 of 47

Author(s): Lundquist, CJ (Lundquist, Carolyn J.); Thrush, SF (Thrush, Simon F.); Coco, G (Coco, Giovanni); Hewitt, JE (Hewitt, Judi E.)

Title: Interactions between disturbance and dispersal reduce persistence thresholds in a benthic community

Source: MARINE ECOLOGY-PROGRESS SERIES, 413: 217-228 2010

Abstract: Interactions between the scale of dispersal and the disturbance regime can lead to radical shifts in the ability of organisms to colonize patches and persist within a landscape. We varied the spatial and temporal rates of disturbance and the connectivity between patches in a model of a patch landscape to illustrate thresholds of community persistence for a marine benthic community. We used model parameters representative of a New Zealand marine biogenic-structured community for which recovery after the cessation of disturbance has been observed within similar to 15 yr. Model results suggest functional extinction of these biogenic communities under many disturbance regimes, and homogenization of the landscape to a community dominated by opportunistic species. Dispersal limitation increases in importance for recovery as the disturbance regime strengthens, indicating thresholds in the tolerable disturbance regime based on the dispersal potential of the dominant biogenic species. Limited sensitivity of our model results to different functional forms of the recovery trajectory and colonization neighborhood suggest that these results can be extrapolated to other biogenic structure-dominated communities with recovery rates of a similar order of magnitude. Our results demonstrate that the scale of the disturbance regime and dispersal processes are fundamentally coupled, and knowing the scales of both processes is imperative when predicting change in the structure and diversity of benthic communities threatened by cumulative change.

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DOI: 10.3354/meps08578

Record 8 of 47

Author(s): Shears, NT (Shears, Nick T.); Ross, PM (Ross, Philip M.)

Title: Toxic cascades: multiple anthropogenic stressors have complex and unanticipated interactive effects on temperate reefs

Source: ECOLOGY LETTERS, 13 (9): 1149-1159 SEP 2010

Abstract: In a changing environment multiple anthropogenic stressors can have novel and non-additive effects on interacting species. We investigated the interactive effects of fishing and harmful algal blooms on the predator-sea urchin-macroalgae trophic cascade. Fishing of urchin predators had indirect negative effects on macroalgae, whereas blooms of epi-benthic dinoflagellates (Ostreopsis siamensis) were found to have strong negative effects on urchins and indirect positive effects on macroalgae. Based on these opposing effects, blooms were expected to counteract the cascading effects of fishing. However, a large bloom of Ostreopsis led to greater divergence in macroalgae abundance

between reserve and fished sites, as urchins declined at reserve sites but remained stable at fished sites. This resulted from enhanced predation rates on bloom-affected urchins at reserve sites rather than direct lethal effects of Ostreopsis on urchins. We argue that interacting stressors can facilitate or attenuate trophic cascades depending on stressor intensity and complex non-lethal interactions.

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Record 9 of 47

Author(s): Claudet, J (Claudet, Joachim); Fraschetti, S (Fraschetti, Simonetta)

Title: Human-driven impacts on marine habitats: A regional meta-analysis in the Mediterranean Sea

Source: BIOLOGICAL CONSERVATION, 143 (9): 2195-2206 SEP 2010

Abstract: Habitat destruction is one of the main threats to environmental integrity. Assessing the consequences of human impacts is crucial both to predict and prevent structural and functional changes of habitats. However, to date almost all studies on marine threats, from regional to global scales, have been entirely qualitative and generally based on little more than expert opinion. We have developed a meta-analytical approach to quantify overall effects of various stressors on different Mediterranean habitat types and to compare the relative importance of different impacts across a range of habitats. We first qualitatively reviewed and synthesized 366 experiments (either manipulative or correlative) collected in the literature. After a selection procedure, we finally quantitatively meta-analyzed 158 experiments. We showed that fisheries (destructive or not), species invasion, aquaculture, sedimentation increase, water degradation and urbanization have negative effects on Mediterranean habitats and associated species assemblages. We also explored the overlap between the impacts identified as important in the Mediterranean and those identified by experts as being important globally, highlighting the inadequacies of relying on expert opinion alone. Finally, we drew attention to the critical lack of empirical knowledge about marine systems in many areas of the Mediterranean, which impedes the implementation of effective conservation measures. Our study is the first to synthesize experimental analyses on human-driven impacts on marine habitats across such a broad geographic scale.

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Record 10 of 47

Author(s): Yoshino, K (Yoshino, Kenji); Hamada, T (Hamada, Takaharu); Yamamoto, K (Yamamoto, Koichi); Hayami, Y (Hayami, Yuichi); Yamaguchi, S (Yamaguchi, Souichi); Ohgushi, K (Ohgushi, Koichiro)

Title: Effects of hypoxia and organic enrichment on estuarine macrofauna in the inner part of Ariake Bay

Source: HYDROBIOLOGIA, 652 (1): 23-38 SEP 2010

Abstract: In the inner part of Ariake Bay, Japan, hypoxia frequently occurs in summer at the organically enriched bottom with salinity stratification caused by flooding after the rainy season. Sediment organic enrichment can work as a stressor for macrobenthos. To investigate the effects of both hypoxia and sediment organic enrichment on macrobenthos, samples were collected at 20 stations by grab sampling in May and August, representing the situation before and after hypoxia, respectively. Although sediment grain size did not change, sediment TOC increased significantly in August. Multivariate analyses showed that the community structure changed significantly in August. The variation in the community structure among stations also increased, which indicated disturbance by stressors during the study period. Similarly, the species richness and total abundance of macrobenthos decreased significantly after hypoxia even after the TOC effect was removed. In addition, the amount of TOC change and the abundance of the main species did not correlate in any case. These results suggest that the community changes during the study period are not caused by stress from the increased sediment TOC but are mainly from the subsequent hypoxic stress.

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DOI: 10.1007/s10750-010-0313-9

Record 11 of 47

Author(s): Foley, MM (Foley, Melissa M.); Halpern, BS (Halpern, Benjamin S.); Micheli, F (Micheli, Fiorenza); Armsby, MH (Armsby, Matthew H.); Caldwell, MR (Caldwell, Margaret R.); Crain, CM (Crain, Caitlin M.); Prahler, E (Prahler, Erin); Rohr, N (Rohr, Nicole); Sivas, D (Sivas, Deborah); Beck, MW (Beck, Michael W.); Carr, MH (Carr, Mark H.); Crowder, LB (Crowder, Larry B.); Duffy, JE (Duffy, J. Emmett); Hacker, SD (Hacker, Sally D.); McLeod, KL (McLeod, Karen L.); Palumbi, SR (Palumbi, Stephen R.); Peterson, CH (Peterson, Charles H.); Regan, HM (Regan, Helen M.); Ruckelshaus, MH (Ruckelshaus, Mary H.); Sandifer, PA (Sandifer, Paul A.); Steneck, RS (Steneck, Robert S.)

Title: Guiding ecological principles for marine spatial planning

Source: MARINE POLICY, 34 (5): 955-966 SEP 2010

Abstract: The declining health of marine ecosystems around the world is evidence that current piecemeal governance is inadequate to successfully support healthy coastal and ocean ecosystems and sustain human uses of the ocean. One proposed solution to this problem is ecosystem-based marine spatial planning (MSP), which is a process that informs the spatial distribution of activities in the ocean so that existing and emerging uses can be maintained, use conflicts reduced, and ecosystem health and services protected and sustained for future generations. Because a key goal of ecosystem-based MSP is to maintain the delivery of ecosystem services that humans want and need, it must be based on ecological principles that articulate the scientifically recognized attributes of healthy, functioning ecosystems. These principles should be incorporated into a decision-making framework with clearly defined targets for these ecological attributes. This paper identifies ecological principles for MSP based on a synthesis of previously suggested and/or operationalized principles, along with recommendations generated by a group of twenty ecologists and marine scientists with diverse backgrounds and perspectives on MSP. The proposed four main ecological principles to guide MSP maintaining or restoring: native species diversity, habitat diversity and heterogeneity, key species, and connectivity and two additional guidelines, the need to account for context and uncertainty, must be explicitly taken into account in the planning process. When applied in concert with social, economic, and governance principles, these ecological principles can inform the designation and siting of ocean uses and the management of activities in the ocean to maintain or restore healthy ecosystems, allow delivery of marine ecosystem services, and ensure sustainable economic and social benefits. (C) 2010 Elsevier Ltd. All rights reserved.

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Record 12 of 47

Author(s): Teck, SJ (Teck, Sarah J.); Halpern, BS (Halpern, Benjamin S.); Kappel, CV (Kappel, Carrie V.); Micheli, F (Micheli, Fiorenza); Selkoe, KA (Selkoe, Kimberly A.); Crain, CM (Crain, Caitlin M.); Martone, R (Martone, Rebecca); Shearer, C (Shearer, Christine); Arvai, J (Arvai, Joe); Fischhoff, B (Fischhoff, Baruch); Murray, G (Murray, Grant); Neslo, R (Neslo, Rabin); Cooke, R (Cooke, Roger)

Title: Using expert judgment to estimate marine ecosystem vulnerability in the California Current

Source: ECOLOGICAL APPLICATIONS, 20 (5): 1402-1416 JUL 2010

Abstract: As resource management and conservation efforts move toward multi-sector, ecosystem-based approaches, we need methods for comparing the varying responses of ecosystems to the impacts of human activities in order to prioritize management efforts, allocate limited resources, and understand cumulative effects. Given the number and variety of human activities affecting ecosystems, relatively few empirical studies are adequately comprehensive to inform these decisions. Consequently, management often turns to expert judgment for information. Drawing on methods from decision science, we offer a method for eliciting expert judgment to (1) quantitatively estimate the relative vulnerability

of ecosystems to stressors, (2) help prioritize the management of stressors across multiple ecosystems, (3) evaluate how experts give weight to different criteria to characterize vulnerability of ecosystems to anthropogenic stressors, and (4) identify key knowledge gaps. We applied this method to the California Current region in order to evaluate the relative vulnerability of 19 marine ecosystems to 53 stressors associated with human activities, based on surveys from 107 experts. When judging the relative vulnerability of ecosystems to stressors, we found that experts primarily considered two criteria: the ecosystem's resistance to the stressor and the number of species or trophic levels affected. Four intertidal ecosystems (mudflat, beach, salt marsh, and rocky intertidal) were judged most vulnerable to the suite of human activities evaluated here. The highest vulnerability rankings for coastal ecosystems were invasive species, ocean acidification, sea temperature change, sea level rise, and habitat alteration from coastal engineering, while offshore ecosystems were assessed to be most vulnerable to ocean acidification, demersal destructive fishing, and shipwrecks. These results provide a quantitative, transparent, and repeatable assessment of relative vulnerability across ecosystems to any ongoing or emerging human activity. Combining these results with data on the spatial distribution and intensity of human activities provides a systematic foundation for ecosystem-based management.

ISSN: 1051-0761

Record 13 of 47

Author(s): Darling, ES (Darling, Emily S.); McClanahan, TR (McClanahan, Timothy R.); Cote, IM (Cote, Isabelle M.)

Title: Combined effects of two stressors on Kenyan coral reefs are additive or antagonistic, not synergistic

Source: CONSERVATION LETTERS, 3 (2): 122-130 APR 2010

Abstract: A challenge for conservation science is predicting the impacts of co-occurring human activities on ecological systems. Multiple anthropogenic and natural stressors impact ecosystems globally and are expected to jeopardize their ecological functions and the success of conservation and management initiatives. The possibility that two or more stressors interact synergistically is of particular concern, but such nonadditive effects remain largely unidentified in nature. A long-term data set of hard coral cover from Kenyan reefs was used to examine the independent and interactive effects of two stressors: fishing and a temperature anomaly in 1998 that caused mass coral bleaching and mortality. While both stressors decreased coral cover, fishing by 51% and bleaching by 74%, they did not interact synergistically. Instead, their combined effect was antagonistic or weakly additive. The observed nonsynergistic response may be caused by the presence of one dominant stressor, bleaching, and cotolerance of coral taxa to both bleaching and fishing stressors. Consequently, coral bleaching has been the dominant driver of coral loss on Kenyan reefs and while marine reserves offer many benefits to reef ecosystems, they may not provide corals with a refuge from climate change.

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Record 14 of 47

Author(s): Sundback, K (Sundback, Kristina); Alsterberg, C (Alsterberg, Christian); Larson, F (Larson, Fredrik)

Title: Effects of multiple stressors on marine shallow-water sediments: Response of microalgae and meiofauna to nutrient-toxicant exposure

Source: JOURNAL OF EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY, 388 (1-2): 39-50 MAY 31 2010

Abstract: Two types of common stressors acting simultaneously on shallow coastal ecosystems include increased anthropogenic nutrient loading and exposure to toxicants. Nutrients (inorganic nitrogen and phosphorus) and the polyaromatic hydrocarbon (PAH) pyrene were added singly and in combination, to study the combined effects of nutrients and toxicants on the base of the food web of a shallow-water illuminated sediment. The microbenthic community of natural sieved, sediment was used in a in a flow-through laboratory experiment lasting 28 days. Variables measured included benthic microalgal and meiofaunal biomass and composition, and meiofaunal grazing rates. The hypotheses were that (i) pyrene exposure affects meiofauna and their grazing rate, resulting in increased benthic

microalgal biomass, and that (ii) pyrene effects depend on nutrient status, as found in previous mesocosm experiments. Our results showed that exposure to a low, environmentally realistic concentration of pyrene had a general negative effect on meiofauna and their grazing rates, although major taxonomical groups differed in response. A concomitant increase in benthic microalgal biomass suggested a cascading effect on the primary producers. Whether there was a significant interaction between pyrene and nutrient status depended on the variable measured. While toxicant effects on total meiofaunal grazing rate, chlorophyll a content of the sediment and microalgal composition depended on nutrient status, the effects on meiofaunal and algal biomass (based on cell counts) did not. We found only partial support for our specific hypothesis that pyrene effects were greater when nutrient concentrations were high. The mode of nutrient-toxicant interaction appeared to vary with variable: non-additive effects (antagonistic or synergistic) were more common than additive effects, but some effects could also be interpreted according to a comparative model. This apparent variation in interaction mode highlights the complexity of nutrient-toxicant interactions - and of multiple stressors in general - in the marine benthic environment, emphasizing the need to consider both structural and functional variables when assessing effects of stressor interactions. Moreover, the presence of potential indirect, food web-mediated effects underlines the need to test multiple-stressor effects using multitrophic communities.

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DOI: 10.1016/j.jembe.2010.03.007

Record 15 of 47

Author(s): Atalah, J (Atalah, Javier); Crowe, TP (Crowe, Tasman P.)

Title: Combined effects of nutrient enrichment, sedimentation and grazer loss on rock pool assemblages

Source: JOURNAL OF EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY, 388 (1-2): 51-57 MAY 31 2010

Abstract: Coastal areas around the world are experiencing increasing disturbance from multiple stressors caused by anthropogenic activities. Although there is good knowledge about the impacts of individual stressors, there is less understanding of the consequences of several stressors acting simultaneously. Eutrophication and sediment deposition are widely recognized as major problems for the functioning of coastal systems, and they are expected to increase during the next decades. In a field experiment, using rock pools as a model system, different levels of nutrients and sedimentation were applied in a factorial experimental design that also accounted for the influence of molluscan grazers. Sedimentation significantly changed assemblage structure, mainly owing to an increase in turfing and filamentous algae and a decrease in crustose algae. Nutrients also caused an increase in the cover of green filamentous algae, which in turn was synergistically magnified by the removal of grazers. Here we showed that these stressors can individually alter the structure of rock pools assemblages; and that in this system top-down control (by grazers) is more important than bottom-up factors (nutrients) in controlling macroalgal assemblage structure. The combined effect of grazers loss and nutrients was larger than the sum of their individual effects. This study enhanced mechanistic understanding of the impacts of multiple stressors on coastal ecosystems, which will help to develop management strategies and conservation of the marine environment.

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Record 16 of 47

Author(s): Perkol-Finkel, S (Perkol-Finkel, Shimrit); Airoldi, L (Airoldi, Laura)

Title: Loss and Recovery Potential of Marine Habitats: An Experimental Study of Factors Maintaining Resilience in Subtidal Algal Forests at the Adriatic Sea

Source: PLOS ONE, 5 (5): Art. No. e10791 MAY 24 2010

Abstract: Background: Predicting and abating the loss of natural habitats present a huge challenge in science, conservation and management. Algal forests are globally threatened by loss and severe recruitment failure, but our understanding of resilience in these systems and its potential disruption by anthropogenic factors lags well behind other habitats. We tested hypotheses regarding triggers for decline and recovery potential in subtidal forests of canopy-forming algae of the genus Cystoseira.
Methodology/Principal Findings: By using a combination of historical data, and quantitative in situ observations of natural recruitment patterns we suggest that recent declines of forests along the coasts of the north Adriatic Sea were triggered by increasing cumulative impacts of natural-and human-induced habitat instability along with several extreme storm events. Clearing and transplantation experiments subsequently demonstrated that at such advanced stages of ecosystem degradation, increased substratum stability would be essential but not sufficient to reverse the loss, and that for recovery to occur removal of the new dominant space occupiers (i.e., opportunistic species including turf algae and mussels) would be required. Lack of surrounding adult canopies did not seem to impair the potential for assisted recovery, suggesting that in these systems recovery could be actively enhanced even following severe depletions.
Conclusions/Significance: We demonstrate that sudden habitat loss can be facilitated by long term changes in the biotic and abiotic conditions in the system, that erode the ability of natural ecosystems to absorb and recover from multiple stressors of natural and human origin. Moreover, we demonstrate that the mere restoration of environmental conditions preceding a loss, if possible, may be insufficient for ecosystem restoration, and is scarcely cost-effective. We conclude that the loss of complex marine habitats in human-dominated landscapes could be mitigated with appropriate consideration and management of incremental habitat changes and of attributes facilitating system recovery.

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Article Number: e10791

DOI: 10.1371/journal.pone.0010791

Record 17 of 47

Author(s): Fukunaga, A (Fukunaga, Atsuko); Anderson, MJ (Anderson, Marti J.); Webster-Brown, JG (Webster-Brown, Jenny G.); Ford, RB (Ford, Richard B.)

Title: Individual and combined effects of heavy metals on estuarine infaunal communities

Source: MARINE ECOLOGY-PROGRESS SERIES, 402: 123-136 2010

Abstract: Heavy metals are anthropogenically introduced into estuaries and cause lethal and sublethal effects on estuarine organisms. Copper (Cu), lead (Pb) and zinc (Zn) are primary sediment contaminants of concern in Auckland, New Zealand. Their concentrations in estuarine sediments tend to correlate with one another spatially across the region, and concentrations of Cu and Zn are predicted to increase over time. A field experiment was done in Orewa estuary, Auckland, to assess the potential effects of Cu, Pb and Zn, individually and in a mixture, on estuarine communities. Surface sediments were replaced with defaunated sediment discs spiked with either Cu (110 mu g g(-1)), Pb (85 mu g g(-1)) or Zn (500 mu g g(-1)), or a mixture of these 3 metals. Infaunal recolonisation was examined after 10 and 20 d. The control, having non-spiked sediments, and the Pb treatment had significantly higher average infaunal abundances and species richness than the Cu, Zn or mixed treatments. The structure of infaunal assemblages in the control and the Pb treatment differed significantly from those in the Cu or Zn treatments, which had lower abundances of polychaetes and the bivalve Macomona liliana. Differential sensitivities of different taxa to the 3 different metals resulted in greater overall impacts on community structure for the mixed treatment than for the treatments spiked with individual metals alone. This experiment clearly showed adverse effects of Cu and Zn on estuarine infauna in the field, indicating that potential increases in metal concentrations in New Zealand's estuaries through time should be treated as a serious environmental concern.

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Record 18 of 47

Author(s): Lester, SE (Lester, Sarah E.); McLeod, KL (McLeod, Karen L.); Tallis, H (Tallis, Heather); Ruckelshaus, M (Ruckelshaus, Mary); Halpern, BS (Halpern, Benjamin S.); Levin, PS (Levin, Phillip S.); Chavez, FP (Chavez, Francisco P.); Pomeroy, C (Pomeroy, Caroline); McCay, BJ (McCay, Bonnie J.); Costello, C (Costello, Christopher); Gaines, SD (Gaines, Steven D.); Mace, AJ (Mace, Amber J.); Barth, JA (Barth, John A.); Fluharty, DL (Fluharty, David L.); Parrish, JK (Parrish, Julia K.)

Title: Science in support of ecosystem-based management for the US West Coast and beyond

Source: BIOLOGICAL CONSERVATION, 143 (3): 576-587 MAR 2010

Abstract: Declining ocean health, increasing human demands on marine ecosystems, and a history of management focused on individual activities, species or sectors has led to calls for more comprehensive, integrated management that considers entire coupled social-ecological systems. This transition to ecosystem-based management (EBM) for the oceans will certainly face a number of hurdles, and many practitioners struggle with how to move forward with EBM. In this paper, we assess whether the necessary science exists to support EBM. Specifically, we evaluate the state of the social and natural sciences for three research areas that are critical to EBM: (1) ecosystem services, (2) cumulative impacts, and (3) ecosystem variability and change. For each of the three research areas, we describe its importance to EBM and assess existing and emerging information and application of this knowledge, focusing on the US West Coast. We conclude that available science is not the bottleneck for moving forward with comprehensive EBM for this region, although we highlight important remaining knowledge gaps, particularly within the social sciences. Given imperfect and uncertain knowledge, EBM calls for an adaptive management approach, starting with readily available information, and continuously adapting as new information emerges. This synthesis can serve as a basis for comparison for other regions; it provides guidance for organizing information in support of EBM and outlines many novel and broadly applicable scientific approaches.

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DOI: 10.1016/j.biocon.2009.11.021

Record 19 of 47

Author(s): Stelzenmuller, V (Stelzenmuller, V.); Lee, J (Lee, J.); South, A (South, A.); Rogers, SI (Rogers, S. I.)

Title: Quantifying cumulative impacts of human pressures on the marine environment: a geospatial modelling framework

Source: MARINE ECOLOGY-PROGRESS SERIES, 398: 19-32 2010

Abstract: Worldwide increasing pressure on the marine environment requires integrated and ecosystem-based management, and a sound understanding of cumulative impacts of human pressure. As yet, the quantification of risk of cumulative impact remains a difficult task in practice. We developed a geospatial modelling framework to group data on the spatial distribution and intensity of human activities by generic pressure. The impact of those pressures was mapped by accounting for the sensitivity of UK marine landscapes to those pressures. With the help of GIS-based multi-criteria analysis, we developed 4 different scenarios to quantify risk of cumulative impacts that accounted for different importance of ranked pressures (equal, linear and logistic decrease), including a simulated expert consultation. Finally, we assessed the sensitivity of the scenario outcomes to changes to input parameters and compared model outcomes. The risk assessment framework exposed both a wide range of possible modelled scenarios and uncertainties, but all scenarios revealed similar locations with an increased risk of cumulative impacts. Results showed that the logistic weighting scheme was very sensitive to changes in the importance and ranking of pressures in comparison to the linear weighting scheme. For marine planning the use of a weighting scheme with more constrained values should be used in conjunction with a sensitivity analysis to determine the order of input parameters. Once a more comprehensive geodatabase becomes available our standardised framework can be applied to support both the development of sustainable marine plans in practise and the prioritisation of different uses.

ISSN: 0171-8630

DOI: 10.3354/meps08345

Record 20 of 47

Author(s): Samhouri, JF (Samhouri, Jameal F.); Levin, PS (Levin, Phillip S.); Harvey, CJ (Harvey, Chris J.)

Title: Quantitative Evaluation of Marine Ecosystem Indicator Performance Using Food Web Models

Source: ECOSYSTEMS, 12 (8): 1283-1298 DEC 2009

Abstract: Successful ecosystem-based management requires the selection and use of informative indicators of ecosystem status. We analyzed seven marine food web models to evaluate the performance of candidate indicators of ecosystem structure and function. The basic approach involved simulating fishing perturbations to each model, measuring the response of ecosystem attributes and candidate indicators to the perturbations, and testing the ability of the indicators to track changes in the values of the attributes. We focused on 22 ecosystem attributes, encompassing structural and functional properties that are relevant to a number of stakeholder groups but are typically difficult to measure directly (for example, food web structure, energy recycling). We tested for correlations between the attributes and 27 empirically tractable candidate indicators (for example, foraging guild biomasses, ratios of community-level groups) within each of the models and quantified consistency in indicator performance across the models. Our analysis suggests that no single indicator is sufficient to describe all of the ecosystem attributes, but at the same time highlights broad, catch-all indicators (for example, detritivores, jellyfish) and distinguishes the strongest attribute-indicator relationships. Ecosystem indicators consisting of lower-trophic level, higher-productivity functional groups tended to perform particularly well. We also identified indicators that showed strong or weak associations with different attributes, but together captured changes in nearly all of them. Examples of such complementary indicators include phytoplankton, zooplanktivorous fish, piscivorous fish, and trophic level of the catch. Quantitative approaches such as this one will enable managers to make informed decisions about ecosystem-scale monitoring in the oceans.

ISSN: 1432-9840

DOI: 10.1007/s10021-009-9286-9

Record 21 of 47

Author(s): Rogell, B (Rogell, B.); Hofman, M (Hofman, M.); Eklund, M (Eklund, M.); Laurila, A (Laurila, A.); Hoglund, J (Hoglund, J.)

Title: The interaction of multiple environmental stressors affects adaptation to a novel habitat in the natterjack toad Bufo calamita

Source: JOURNAL OF EVOLUTIONARY BIOLOGY, 22 (11): 2267-2277 NOV 2009

Abstract: The potential to adapt to novel environmental conditions is a key area of interest for evolutionary biology. However, the role of multiple selection pressures on adaptive responses has rarely been investigated in natural populations. In Sweden, the natterjack toad Bufo calamita inhabits two separate distribution areas, one in southernmost Sweden and one on the west coast. We characterized the larval habitat in terms of pond size and salinity in the two areas, and found that the western populations are more affected by both desiccation risk and pond salinity than the southern populations. In a common garden experiment manipulating salinity and temperature, we found that toads from the west coast populations were locally adapted to shorter pond duration as indicated by their higher development and growth rates. However, despite being subjected to higher salinity stress in nature, west coast toads had a poorer performance in saline treatments. We found that survival in the saline treatments in the west coast populations was positively affected by larger body mass and longer larval period. Furthermore, we found negative genetic correlations between body mass and growth rate and their plastic responses to salinity. These results implicate that the occurrence of multiple environmental stressors needs to be accounted for when assessing the adaptive potential of organisms and suggest that genetic correlations may play a role in constraining adaptation of natural populations.

ISSN: 1010-061X

DOI: 10.1111/j.1420-9101.2009.01842.x

Record 22 of 47

Author(s): Firth, LB (Firth, Louise B.); Williams, GA (Williams, Gray. A.)

Title: The influence of multiple environmental stressors on the limpet Cellana toreuma during the summer monsoon season in Hong Kong

Source: JOURNAL OF EXPERIMENTAL MARINE BIOLOGY AND ECOLOGY, 375 (1-2): 70-75 JUL 15 2009

Abstract: Although environmental stressors affect natural systems in a multitude of ways, the interactive effect of multiple stressors on ecological assemblages remains largely misunderstudied. On tropical shores which experience seasonal monsoons, rocky intertidal habitats are physiologically stressful environments, being strongly affected by high temperatures and monsoon rains during emersion. In Hong Kong the limpet, Cellana toreuma, often takes refuge in mid-shore tidepools. In summer, these populations experience high mortality, probably as a result of stressful environmental conditions during low-spring tide days with high temperatures and/or intense rainfall periods can occur. Laboratory experiments were designed to mimic the effects of temperature stress (and increasing pool salinity) and reduced salinity as a result of monsoon rains on C. toreuma in tidepools. In general, haemolymph osmolality increased with salinity and limpet mortality increased with temperature. As salinity decreased after simulated rainfall, haemolymph osmolality (after 60 min) and survival (after 180 min) were significantly lower than in control treatments. Salinity fluctuations, coupled with high temperatures during emersion had both sub-lethal physiological effects and lethal effects on limpets in tidepools. Conducting experiments of multiple stressors simultaneously, however, revealed no interaction between hot temperatures and salinity variation, both of which operated independently for different response variables. Individually, therefore, hot temperatures and large salinity changes associated with the wet monsoon season are likely to play an important role in the population dynamics of intertidal species such as C. toreuma, and as a result will influence the structure and functioning of tropical rocky shores.

ISSN: 0022-0981

DOI: 10.1016/j.jembe.2009.05.011

Record 23 of 47

Author(s): Crain, CM (Crain, Caitlin M.); Halpern, BS (Halpern, Benjamin S.); Beck, MW (Beck, Mike W.); Kappel, CV (Kappel, Carrie V.)

Title: Understanding and Managing Human Threats to the Coastal Marine Environment

Source: YEAR IN ECOLOGY AND CONSERVATION BIOLOGY 2009, 1162: 39-62 2009

Book series title: ANNALS OF THE NEW YORK ACADEMY OF SCIENCES

Abstract: Coastal marine habitats at the interface of land and sea are subject to threats from human activities in both realms. Researchers have attempted to quantify how these various threats impact different coastal ecosystems, and more recently have focused on understanding the cumulative impact from multiple threats. Here, the top threats to coastal marine ecosystems and recent efforts to understand their relative importance, ecosystem-level impacts, cumulative effects, and how they can best be managed and mitigated, are briefly reviewed. Results of threat analysis and rankings will differ depending on the conservation target (e.g., vulnerable species, pristine ecosystems, mitigatable threats), scale of interest (local, regional, or global), whether externalities are considered, and the types of management tools available (e.g., marine-protected areas versus ecosystem-based management). Considering the cumulative effect of multiple threats has only just begun and depends on spatial analysis to predict overlapping threats and a better understanding of multiple-stressor effects and interactions. Emerging conservation practices that hold substantial promise for protecting coastal marine systems include multisector approaches, such as ecosystem-based management (EBM), that account for ecosystem service valuation; comprehensive spatial management, such as ocean zoning; and regulatory mechanisms that encourage or require cross-sector goal setting and evaluation. In all cases, these efforts require a combination of public

and private initiatives for success. The state of our ecological understanding, public awareness, and policy initiatives make the time ripe for advancing coastal marine management and improving our stewardship of coastal and marine ecosystems.

ISSN: 0077-8923

DOI: 10.1111/j.1749-6632.2009.04496.x

Record 24 of 47

Author(s): Uriarte, A (Uriarte, Ainhize); Borja, A (Borja, Angel)

Title: Assessing fish quality status in transitional waters, within the European Water Framework Directive: Setting boundary classes and responding to anthropogenic pressures

Source: ESTUARINE COASTAL AND SHELF SCIENCE, 82 (2): 214-224 APR 10 2009

Abstract: Validation of the AZTI's Fish Index (AFI), proposed for the Basque Country (northern Spain), in assessing fish quality within the Water Framework Directive (WFD), is under-taken. The response to anthropogenic pressure is investigated, in setting the boundaries between the different quality status classes. Hence, 12 estuaries were sampled, at different frequencies, between 1989 and 2007, by means of a beam trawl. Significant ($p < 0.0001$) correlations were found between the AFI and oxygen saturation and ammonia. Oxygen quality standards are used to set boundaries between quality classes. Then, the AFIs obtained are compared with different anthropogenic pressures, including urban and industrial discharges, engineering works and dredging. The effects of the removal of some of these pressures are also studied. The total number of pressures within an estuary shows significant ($p < 0.009$) negative correlation with AFI, explaining between 51 and 62% of the variability in fish quality. The impact of pressures upon fish and demersal assemblages is detected as required by the WFD. Nonetheless, further investigation and intercalibration of the methods used, are necessary.

ISSN: 0272-7714

DOI: 10.1016/j.ecss.2009.01.008

Record 25 of 47

Author(s): Crain, CM (Crain, Caitlin Mullan); Kroeker, K (Kroeker, Kristy); Halpern, BS (Halpern, Benjamin S.)

Title: Interactive and cumulative effects of multiple human stressors in marine systems

Source: ECOLOGY LETTERS, 11 (12): 1304-1315 DEC 2008

Abstract: Humans impact natural systems in a multitude of ways, yet the cumulative effect of multiple stressors on ecological communities remains largely unknown. Here we synthesized 171 studies that manipulated two or more stressors in marine and coastal systems and found that cumulative effects in individual studies were additive (26%), synergistic (36%), and antagonistic (38%). The overall interaction effect across all studies was synergistic, but interaction type varied by response level (community: antagonistic, population: synergistic), trophic level (autotrophs: antagonistic, heterotrophs: synergistic), and specific stressor pair (seven pairs additive, three pairs each synergistic and antagonistic). Addition of a third stressor changed interaction effects significantly in two-thirds of all cases and doubled the number of synergistic interactions. Given that most studies were performed in laboratories where stressor effects can be carefully isolated, these three-stressor results suggest that synergies may be quite common in nature where more than two stressors almost always coexist. While significant gaps exist in multiple stressor research, our results suggest an immediate need to account for stressor interactions in ecological studies and conservation planning.

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DOI: 10.1111/j.1461-0248.2008.01253.x

Record 26 of 47

Author(s): Crain, CM (Crain, Caitlin Mullan)

Title: Interactions between marsh plant species vary in direction and strength depending on environmental and consumer context

Source: JOURNAL OF ECOLOGY, 96 (1): 166-173 JAN 2008

Abstract: 1. Positive interactions between species are predicted to increase in importance at extreme ends of environmental gradients where neighbours offer either stress amelioration in harsh environments or associational defence from consumers in benign environments. However, this model has never been tested with the same species across a single environmental gradient in light of consumers.
2. Estuarine marsh vegetation, at a landscape-scale from salt to tidal freshwater, experiences strong gradients in physical (salinity) stress, but consumer effects are rarely considered in these systems under strong edaphic control. Here, I present evidence that small mammals are important consumers in coastal marshes of New England, USA, reducing vegetative cover by maintaining open runways in all salinity marshes, but whose top-down influence on plant species increases in less saline marshes.
3. A seedling transplant experiment into plots with and without neighbouring matrix grasses, and with varying environmental stress (salt, brackish and oligohaline marshes) and consumer pressure (with and without mammal herbivory), showed that seedling-matrix interactions were positive in salt marshes, negative in brackish marshes, and varied in oligohaline marshes depending on species. While competitive interactions predominated in oligohaline marshes, one transplant species had less negative neighbour interactions in the presence of consumers, indicating an increasing positive component of the interaction due to associational defence.
4. Synthesis. These results suggest that positive interactions may occur more consistently in harsh physical environments than in stressful biotic environments because consumer pressure is likely to vary by species and over space and time, while environmental stress is generally applied more constantly. Results show that interactions between the same species can reverse in direction or change in strength depending on environmental and consumer context, cautioning that single-site studies may not accurately predict community changes in increasingly altered climatic and consumer environments.

ISSN: 0022-0477

DOI: 10.1111/j.1365-2745.2007.01314.x

Record 27 of 47

Author(s): Leslie, HM (Leslie, Heather M.); McLeod, KL (McLeod, Karen L.)

Title: Confronting the challenges of implementing marine ecosystem-based management

Source: FRONTIERS IN ECOLOGY AND THE ENVIRONMENT, 5 (10): 540-548 DEC 2007

Abstract: Many services provided by coastal and marine ecosystems are in decline. Awareness of these declines and the need to improve existing management has led to a shift toward ecosystem-based approaches to marine management and conservation, both in the US and elsewhere. Marine ecosystem-based management (EBM) involves recognizing and addressing interactions among different spatial and temporal scales, within and among ecological and social systems, and among stakeholder groups and communities interested in the health and stewardship of coastal and marine areas. We discuss some overarching principles of marine EBM and highlight key challenges facing implementation. We then recommend ways in which natural and social scientists can advance implementation of ecosystem-based approaches in the oceans by addressing key research needs, building interdisciplinary scientific capacity, and synthesizing and communicating scientific knowledge to policy makers, managers, and other stakeholders.

ISSN: 1540-9295

Record 28 of 47

Author(s): Halpern, BS (Halpern, Benjamin S.); Selkoe, KA (Selkoe, Kimberly A.); Micheli, F (Micheli, Fiorenza); Kappel, CV (Kappel, Carrie V.)

Title: Evaluating and ranking the vulnerability of global marine ecosystems to anthropogenic threats

Source: CONSERVATION BIOLOGY, 21 (5): 1301-1315 OCT 2007

Abstract: Marine ecosystems are threatened by a suite of anthropogenic stressors. Mitigating multiple threats is a daunting task, particularly when funding constraints limit the number of threats that can be addressed. Threats are typically assessed and prioritized via expert opinion workshops that often leave no record of the rationale for decisions, making it difficult to update recommendations with new information. We devised a transparent, repeatable, and modifiable method for collecting expert opinion that describes and documents how threat,,; affect marine ecosystems. Experts were asked to assess the functional impact, scale, and frequency of a threat to an ecosystem; the resistance and recovery time of an ecosystem to a threat; and the certainty of these estimates. To quantify impacts of 38 distinct anthropogenic threats on 23 marine ecosystems, we surveyed 135 experts from 19 different countries. Survey results showed that all ecosystems are threatened by at least nine threats and that nine ecosystems are threatened by >90% of existing threats. The greatest threats (highest impact scores) were increasing sea temperature, demersal destructive fishing, and point-source organic pollution. Rocky reef, coral reef, hard-shelf, mangrove, and offshore epipelagic ecosystems were identified as the most threatened. These general results, however, may be partly influenced by the specific expertise and geography of respondents, and should be interpreted with caution. This approach to threat analysis can identify the greatest threats (globally or locally), most widespread threats, most (or least) sensitive ecosystems, most (or least) threatened ecosystems, and other metrics of conservation value. Additionally, it can be easily modified, updated as new data become available, and scaled to local or regional settings, which would facilitate informed and transparent conservation priority setting.

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DOI: 10.1111/j.1523-1739.2007.00752.x

Record 29 of 47

Author(s): Mora, C (Mora, Camilo); Metzger, R (Metzger, Rebekka); Rollo, A (Rollo, Audrey); Myers, RA (Myers, Ransom A.)

Title: Experimental simulations about the effects of overexploitation and habitat fragmentation on populations facing environmental warming

Source: PROCEEDINGS OF THE ROYAL SOCIETY B-BIOLOGICAL SCIENCES, 274 (1613): 1023-1028 APR 22 2007

Abstract: Populations of many species are dramatically declining worldwide, but the causal mechanism remains debated among different human-related threats. Coping with this uncertainty is critical to several issues about the conservation and future of biodiversity, but remains challenging due to difficulties associated with the experimental manipulation and/or isolation of the effects of such threats under field conditions. Using controlled microcosm populations, we quantified the individual and combined effects of environmental warming, overexploitation and habitat fragmentation on population persistence. Individually, each of these threats produced similar and significant population declines, which were accelerated to different degrees depending upon particular interactions. The interaction between habitat fragmentation and harvesting generated an additive decline in population size. However, both of these threats reduced population resistance causing synergistic declines in populations also facing environmental warming. Declines in population size were up to 50 times faster when all threats acted together. These results indicate that species may be facing risks of extinction higher than those anticipated from single threat analyses and suggest that all threats should be mitigated simultaneously, if current biodiversity declines are to be reversed.

ISSN: 0962-8452

DOI: 10.1098/rspb.2006.0338

Record 30 of 47

Author(s): Burkepile, DE (Burkepile, Deron E.); Hay, ME (Hay, Mark E.)

Title: Herbivore vs. nutrient control of marine primary producers: Context-dependent effects

Source: ECOLOGY, 87 (12): 3128-3139 DEC 2006

Abstract: Pervasive overharvesting of consumers and anthropogenic nutrient loading are changing the strengths of top-down and bottom-up forces in ecosystems worldwide. Thus, identifying the relative and synergistic roles of these forces and how they differ across habitats, ecosystems, or primary-producer types is increasingly important for understanding how communities are structured. We used factorial meta-analysis of 54 field experiments that orthogonally manipulated herbivore pressure and nutrient loading to quantify consumer and nutrient effects on primary producers in benthic marine habitats. Across all experiments and producer types, herbivory and nutrient enrichment both significantly affected primary-producer abundance. They also interacted to create greater nutrient enrichment effects in the absence of herbivores, suggesting that loss of herbivores produces more dramatic effects of nutrient loading. Herbivores consistently had stronger effects than did nutrient enrichment for both tropical macroalgae and seagrasses. The strong effects of herbivory but limited effects of nutrient enrichment on tropical macroalgae suggest that suppression of herbivore populations has played a larger role than eutrophication in driving the phase shift from coral-to macroalgal-dominated reefs in many areas, especially the Caribbean. For temperate macroalgae and benthic microalgae, the effects of top-down and bottom-up forces varied as a function of the inherent productivity of the ecosystem. For these algal groups, nutrient enrichment appeared to have stronger effects in high-vs. low-productivity systems, while herbivores exerted a stronger top-down effect in low-productivity systems. Effects of herbivores vs. nutrients also varied among algal functional groups (crustose algae, upright macroalgae, and filamentous algae), within a functional group between temperate and tropical systems, and according to the metric used to measure producer abundance. These analyses suggest that human alteration of food webs and nutrient availability have significant effects on primary producers but that the effects vary among latitudes and primary producers, and with the inherent productivity of ecosystems.

ISSN: 0012-9658

Record 31 of 47

Author(s): Christensen, MR (Christensen, Michael R.); Graham, MD (Graham, Mark D.); Vinebrooke, RD (Vinebrooke, Rolf D.); Findlay, DL (Findlay, David L.); Paterson, MJ (Paterson, Michael J.); Turner, MA (Turner, Michael A.)

Title: Multiple anthropogenic stressors cause ecological surprises in boreal lakes

Source: GLOBAL CHANGE BIOLOGY, 12 (12): 2316-2322 DEC 2006

Abstract: The number of combinations of anthropogenic stressors affecting global change is increasing; however, few studies have empirically tested for their interactive effects on ecosystems. Most importantly, interactions among ecological stressors generate nonadditive effects that cannot be easily predicted based on single-stressor studies. Here, we corroborate findings from an in situ mesocosm experiment with evidence from a whole-ecosystem manipulation to demonstrate for the first time that interactions between climate and acidification determine their cumulative impact on the food-web structure of coldwater lakes. Interactions among warming, drought, and acidification, rather than the sum of their individual effects, best explained significant changes in planktonic consumer and producer biomass over a 23-year period. Further, these stressors interactively exerted significant synergistic and antagonistic effects on consumers and producers, respectively. The observed prevalence of long- and short-term ecological surprises involving the cumulative impacts of multiple anthropogenic stressors highlights the high degree of uncertainty surrounding current forecasts of the consequences of global change.

ISSN: 1354-1013

DOI: 10.1111/j.1365-2486.2006.01257.x

Record 32 of 47

Author(s): Worm, B (Worm, Boris); Barbier, EB (Barbier, Edward B.); Beaumont, N (Beaumont, Nicola); Duffy, JE (Duffy, J. Emmett); Folke, C (Folke, Carl); Halpern, BS (Halpern, Benjamin S.); Jackson, JBC (Jackson, Jeremy B. C.); Lotze, HK (Lotze, Heike K.); Micheli, F (Micheli, Fiorenza); Palumbi, SR (Palumbi, Stephen R.); Sala, E (Sala, Enric); Selkoe, KA (Selkoe, Kimberley A.); Stachowicz, JJ (Stachowicz, John J.); Watson, R (Watson, Reg)

Title: Impacts of biodiversity loss on ocean ecosystem services

Source: SCIENCE, 314 (5800): 787-790 NOV 3 2006

Abstract: Human-dominated marine ecosystems are experiencing accelerating loss of populations and species, with largely unknown consequences. We analyzed local experiments, long-term regional time series, and global fisheries data to test how biodiversity loss affects marine ecosystem services across temporal and spatial scales. Overall, rates of resource collapse increased and recovery potential, stability, and water quality decreased exponentially with declining diversity. Restoration of biodiversity, in contrast, increased productivity fourfold and decreased variability by 21%, on average. We conclude that marine biodiversity loss is increasingly impairing the ocean's capacity to provide food, maintain water quality, and recover from perturbations. Yet available data suggest that at this point, these trends are still reversible.

ISSN: 0036-8075

DOI: 10.1126/science.1132294

Record 33 of 47

Author(s): Relyea, R (Relyea, Rick); Hoverman, J (Hoverman, Jason)

Title: Assessing the ecology in ecotoxicology: a review and synthesis in freshwater systems

Source: ECOLOGY LETTERS, 9 (10): 1157-1171 OCT 2006

Abstract: The field of ecotoxicology is experiencing a surge in attention among ecologists as we gain a deeper appreciation for how contaminants can impact natural ecosystems. This interest is particularly strong in aquatic systems where many non-target organisms experience pesticides. In this article, we assess how pesticides affect freshwater systems by applying the conceptual framework of density- and trait-mediated indirect effects from the field of basic ecology. We demonstrate the utility of this framework for understanding the conditions under which pesticides affect species interactions, communities and ecosystems. Through the integration of laboratory toxicity tests and this ecological framework, ecotoxicologists should be better able to identify the mechanisms through which pesticides affect communities and ecosystems. We also identify several areas of research that are in critical need of empirical attention including synergistic effects between pesticides and natural stressors, the importance of pesticides on community assembly via habitat preferences and oviposition effects, the timing and frequency of pesticide applications, pesticide effects on population dynamics, the evolution of pesticide resistance in non-target organisms and ecosystem recovery. With this knowledge, one can improve upon management decisions and help protect non-target species that are of conservation concern.

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DOI: 10.1111/j.1461-0248.2006.00966.x

Record 34 of 47

Author(s): Pelletier, E (Pelletier, E.); Sargian, P (Sargian, P.); Payet, J (Payet, J.); Demers, S (Demers, S.)

Title: Ecotoxicological effects of combined UVB and organic contaminants in coastal waters: A review

Source: PHOTOCHEMISTRY AND PHOTOBIOLOGY, 82 (4): 981-993 JUL-AUG 2006

Abstract: Organisms living in coastal waters are exposed to anthropogenic contaminants from terrestrial drainage, ice melting and maritime traffic and to enhanced UVB radiation (UVBR; 280-320 nm) caused by decreased concentrations of ozone in the stratosphere. This article reviews available information about the combined effects of UVBR and selected

hydrosoluble contaminants potentially present in surface waters on marine species and especially on plankton community structure in high-latitude coastal zones. Effects of UVBR on three selected pesticides (Atrazine, carbaryl and Acifluorfen) and possible induction of phototoxicity are reviewed. Most toxicological studies have been conducted under laboratory conditions with questionable relevance for coastal marine ecosystems. Similarly, photoactivation of polycyclic aromatic hydrocarbons (PAHs) has been closely examined and reported effects on aquatic species summarized. Experiments with field-sampled communities demonstrated the complexity and the difficulty in determining the impact of multiple stressors on an aquatic ecosystem, even for ecosystems simplified by eliminating large grazers and fish. Nutrient status, specific composition and light history have influenced the different responses of planktonic assemblages exposed to enhanced UVBR and water-soluble fraction (WSF) from crude oil or to tributyltin. Plankton assemblages subjected to changes in the ozone hole were physiologically stressed and more susceptible to WSF toxicity than communities from less enhanced UVBR-impacted sites. A close relationship between phytoplankton assemblages and bacteria was observed in all experiments in mesocosms. A contaminant-induced phytoplankton crash after a bloom event may release important carbon and nutrient sources for bacteria. The magnitude of phytoplanktonic mortality induced by a contaminant probably influenced how rapidly bacteria grew over time. The transition from a herbivorous food web to a microbial food web has significant ecological implications for carbon cycling and energy flow in pelagic systems. A high phytoplankton mortality implies a situation in which the potential for downward carbon export from surface waters is high. In contrast, high bacterial enrichment implies that the phytoplankton carbon is largely recycled in surface waters through a microbial loop and does not contribute significantly to sinking particle flux. The most ecologically relevant results were obtained with mesocosm studies using field-collected communities. The enhancement of hydrocarbon toxicity in the presence of a high level of UVBR cannot be described as being a synergistic or an additive effect, because the WSF alone is not toxic and may even be beneficial by increasing bacterial activity. This is a case in which one stressor has the ability to modify another stressor to cause it to be toxic to target organisms. These abiotically induced interactions may be important for biological communities exposed to extreme conditions when physical, chemical or photochemical reactions modify the nature of environmental stressors before they interact with biological functions. The need for models on the impacts of multiple stressors on biodiversity and ecosystem functioning is emphasized.

ISSN: 0031-8655

Record 35 of 47

Author(s): Dudgeon, D (Dudgeon, David); Arthington, AH (Arthington, Angela H.); Gessner, MO (Gessner, Mark O.); Kawabata, ZI (Kawabata, Zen-Ichiro); Knowler, DJ (Knowler, Duncan J.); Leveque, C (Leveque, Christian); Naiman, RJ (Naiman, Robert J.); Prieur-Richard, AH (Prieur-Richard, Anne-Helene); Soto, D (Soto, Doris); Stiassny, MLJ (Stiassny, Melanie L. J.); Sullivan, CA (Sullivan, Caroline A.)

Title: Freshwater biodiversity: importance, threats, status and conservation challenges

Source: BIOLOGICAL REVIEWS, 81 (2): 163-182 MAY 2006

Abstract: Freshwater biodiversity is the over-riding conservation priority during the International Decade for Action -'Water for Life'-2005 to 2015. Fresh water makes up only 0.01% of the World's water and approximately 0.8% of the Earth's surface, yet this tiny fraction of global water supports at least 100 000 species out of approximately 1.8 million - almost 6% of all described species. Inland waters and freshwater biodiversity constitute a valuable natural resource, in economic, cultural., aesthetic, scientific and educational terms. Their conservation and management are critical to the interests of all humans, nations and governments. Yet this precious heritage is in crisis. Fresh waters are experiencing declines in biodiversity far greater than those in the most affected terrestrial ecosystems, and if trends in human demands for water remain unaltered and species losses continue at current rates, the opportunity to conserve much of the remaining biodiversity in fresh water will vanish before the 'Water for Life' decade ends in 2015. Why is this so, and what is being done about it? This article explores the special features of freshwater habitats and the biodiversity they support that makes them especially vulnerable to human activities. We document threats to global freshwater biodiversity under five headings: overexploitation; water pollution; flow modification; destruction or degradation of habitat; and invasion by exotic species. Their combined and interacting influences have resulted in population declines and range

reduction of freshwater biodiversity worldwide. Conservation of biodiversity is complicated by the landscape position of rivers and wetlands as 'receivers' of land-use effluents, and the problems posed by endemism and thus non-substitutability. In addition, in man), parts of the world, fresh water is subject to severe competition among multiple human stakeholders. Protection of freshwater biodiversity is perhaps the ultimate conservation challenge because it is influenced by the upstream drainage network, the surrounding land, the riparian zone, and - in the case of migrating aquatic fauna - downstream reaches. Such prerequisites are hardly ever met. Immediate action is needed where opportunities exist to set aside intact take and river ecosystems within large protected areas. For most of the global land surface, trade-offs between conservation of freshwater biodiversity and human use of ecosystem goods and services are necessary. We advocate continuing attempts to check species loss but, in many situations, urge adoption of a compromise position of management for biodiversity conservation, ecosystem functioning and resilience, and human livelihoods in order to provide a viable long-term basis for freshwater conservation. Recognition of this need will require adoption of a new paradigm for biodiversity protection and freshwater ecosystem management - one that has been appropriately termed 'reconciliation ecology'.

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DOI: 10.1017/S1464793105006950

Record 36 of 47

Author(s): Rosenberg, AA; McLeod, KL

Title: Implementing ecosystem-based approaches to management for the conservation of ecosystem services

Source: MARINE ECOLOGY-PROGRESS SERIES, 300: 270-274 2005

ISSN: 0171-8630

Record 37 of 47

Author(s): Stoms, DM; Davis, FW; Andelman, SJ; Carr, MH; Gaines, SD; Halpern, BS; Hoenicke, R; Leibowitz, SG; Leydecker, A; Madin, EMP; Tallis, H; Warner, RR

Title: Integrated coastal reserve planning: making the land-sea connection

Source: FRONTIERS IN ECOLOGY AND THE ENVIRONMENT, 3 (8): 429-436 OCT 2005

Abstract: Land use, watershed processes, and coastal biodiversity are often intricately linked, yet land-sea interactions are usually ignored when selecting terrestrial and marine reserves with existing models. Such oversight increases the risk that reserves will fail to achieve their conservation objectives. The conceptual model underlying existing reserve selection models presumes each site is a closed ecological system, unaffected by inputs from elsewhere. As a short-term objective, we recommend extending land-conservation analyses to account for effects on marine biodiversity by considering linkages between ecosystems. This level of integration seems feasible and directly relevant to agencies and conservancies engaged in protecting coastal lands. We propose an approach that evaluates terrestrial sites based on whether they benefit or harm marine species or habitats. We then consider a hypothetical example involving estuarine nurseries. Whether this approach will produce more effective terrestrial reserves remains to be seen.

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Record 38 of 47

Author(s): Kappel, CV

Title: Losing pieces of the puzzle: threats to marine, estuarine, and diadromous species

Source: FRONTIERS IN ECOLOGY AND THE ENVIRONMENT, 3 (5): 275-282 JUN 2005

Abstract: The number of marine species at risk of extinction is rising. Understanding the threats that contribute to extinction risk in the seas is thus critical to conservation. When major threats to marine, estuarine, and diadromous species on the US Endangered Species Act and IUCN Red lists were ranked according to the number of species they affect, strong consensus in the ranking of threats across species and between institutions emerged. Overexploitation is the most frequent threat to vulnerable marine species, with approximately half of threatened species caught as bycatch in fisheries. Habitat degradation, the primary threat to terrestrial species, ranks second in impact on marine species. Loss of listed marine species would probably affect ecosystem function and delivery of ecosystem services because many of these species are strong interactors, including ecosystem engineers, taxa that provide important nutrient links between terrestrial and marine ecosystems, and a disproportionate number of high trophic-level predators.

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Record 39 of 47

Author(s): Przeslawski, R; Davis, AR; Benkendorff, K

Title: Synergistic effects associated with climate change and the development of rocky shore molluscs

Source: GLOBAL CHANGE BIOLOGY, 11 (3): 515-522 MAR 2005

Abstract: Global climate change and ozone layer thinning will simultaneously expose organisms to increasingly stressful conditions. Early life stages of marine organisms, particularly eggs and larvae, are considered most vulnerable to environmental extremes. Here, we exposed encapsulated embryos of three common rocky shore gastropods to simultaneous combinations of ecologically realistic levels of ultraviolet radiation (UVR), water temperature stress and salinity stress to identify potential interactions and associated impacts of climate change. We detected synergistic effects with increases in mortality and retardation in development associated with the most physiologically stressful conditions. The effects of UVR were particularly marked, with mortality increasing up to 12-fold under stressful conditions. Importantly, the complex outcomes observed on applying multiple stressors could not have been predicted from examining environmental variables in isolation. Hence, we are probably dramatically underestimating the ecological impacts of climate change by failing to consider the complex interplay of combinations of environmental variables with organisms.

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DOI: 10.1111/j.1365-2486.2005.00918.x

Record 40 of 47

Author(s): Vinebrooke, RD; Cottingham, KL; Norberg, J; Scheffer, M; Dodson, SI; Maberly, SC; Sommer, U

Title: Impacts of multiple stressors on biodiversity and ecosystem functioning: the role of species co-tolerance

Source: OIKOS, 104 (3): 451-457 MAR 2004

Abstract: Ecosystem resistance to a single stressor relies on tolerant species that can compensate for sensitive competitors and maintain ecosystem processes, such as primary production. We hypothesize that resistance to additional stressors depends increasingly on species tolerances being positively correlated (i.e. positive species co-tolerance). Initial exposure to a stressor combined with positive species co-tolerance should reduce the impacts of other stressors, which we term stress-induced community tolerance. In contrast, negative species co-tolerance is expected to result in additional stressors having pronounced additive or synergistic impacts on biologically impoverished functional groups, which we term stress-induced community sensitivity. Therefore, the sign and strength of the correlation between species sensitivities to multiple stressors must be considered when predicting the impacts of global change on ecosystem functioning as mediated by changes in biodiversity.

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Record 41 of 47

Author(s): Stachowicz, JJ; Terwin, JR; Whitlatch, RB; Osman, RW

Title: Linking climate change and biological invasions: Ocean warming facilitates nonindigenous species invasions

Source: PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA, 99 (24): 15497-15500 NOV 26 2002

Abstract: The spread of exotic species and climate change are among the most serious global environmental threats. Each independently causes considerable ecological damage, yet few data are available to assess whether changing climate might facilitate invasions by favoring introduced over native species. Here, we compare our long-term record of weekly sessile marine invertebrate recruitment with interannual variation in water temperature to assess the likely effect of climate change on the success and spread of introduced species. For the three most abundant introduced species of ascidian (sea squirt), the timing of the initiation of recruitment was strongly negatively correlated with winter water temperature, indicating that invaders arrived earlier in the season in years with warmer winters. Total recruitment of introduced species during the following summer also was positively correlated with winter water temperature. In contrast, the magnitude of native ascidian recruitment was negatively correlated with winter temperature (more recruitment in colder years) and the timing of native recruitment was unaffected. In manipulative laboratory experiments, two introduced compound ascidians grew faster than a native species, but only at temperatures near the maximum observed in summer. These data suggest that the greatest effects of climate change on biotic communities may be due to changing maximum and minimum temperatures rather than annual means. By giving introduced species an earlier start, and increasing the magnitude of their growth and recruitment relative to natives, global warming may facilitate a shift to dominance by nonnative species, accelerating the homogenization of the global biota.

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DOI: 10.1073/pnas.242437499

Record 42 of 47

Author(s): Sanderson, EW; Jaiteh, M; Levy, MA; Redford, KH; Wannebo, AV; Woolmer, G

Title: The human footprint and the last of the wild

Source: BIOSCIENCE, 52 (10): 891-904 OCT 2002

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Record 43 of 47

Author(s): Blanck, H

Title: A critical review of procedures and approaches used for assessing pollution-induced community tolerance (PICT) in biotic communities

Source: HUMAN AND ECOLOGICAL RISK ASSESSMENT, 8 (5): 1003-1034 AUG 2002

Abstract: Pollution-induced community tolerance (PICT) is used for the detection of minor effects of toxicants in biotic communities. Organisms survive in toxic environments only if they are tolerant to the chemicals present in their habitat. In the selection phase, toxicants hinder the success of sensitive individuals and species and replace them by more tolerant ones. The resulting increase in community tolerance is quantified in the detection phase by short-term toxicity tests. In this way PICT can establish causal linkages between contaminants and effects. An increase in community tolerance compared to the baseline tolerance at reference sites suggests that the community has been adversely affected by toxicants. PICT has been used in aquatic and terrestrial environments with communities of periphyton, phytoplankton, bacteria, nematodes and insects. A variety of methods have been used for quantification of community tolerance including photosynthesis, sulfolipid synthesis, respiration, thymidine and leucine incorporation, survival, and substrate utilisation patterns. PICT has been observed for copper, zinc, nickel, mercury, cadmium, arsenate, monomethylarsonic acid, diuron, tributyl tin, 4,5,6-trichloroguaiacol, irgarol 1051, seanine 211, atrazine, and trinitrotoluene. It is necessary to validate PICT, at least by showing that it is related to the preexposure concentration of the toxicants and that it is coupled

to a toxicant-induced succession (TIS) in the community. Care must also be taken to ascertain that PICT interpretation is not confounded by co-tolerance or bioavailability differences. Co-tolerance patterns, which are indicative of the specificity of PICT, have only been investigated for arsenate, diuron and a few metals. For the further improvement of PICT methodology special attention should be given to co-tolerance patterns and development of new integrating short-term tests for quantification of tolerance. It is also important to broaden the scope of organisms and toxicants used. Properly validated, PICT is a powerful tool for detection of community effects and its use in monitoring and site-specific risk assessment should be encouraged.

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Record 44 of 47

Author(s): Harvell, CD; Kim, K; Burkholder, JM; Colwell, RR; Epstein, PR; Grimes, DJ; Hofmann, EE; Lipp, EK; Osterhaus, ADME; Overstreet, RM; Porter, JW; Smith, GW; Vasta, GR

Title: Review: Marine ecology - Emerging marine diseases - Climate links and anthropogenic factors

Source: SCIENCE, 285 (5433): 1505-1510 SEP 3 1999

Abstract: Mass mortalities due to disease outbreaks have recently affected major taxa in the oceans. For closely monitored groups like corals and marine mammals, reports of the frequency of epidemics and the number of new diseases have increased recently. A dramatic global increase in the severity of coral bleaching in 1997-98 is coincident with high El Nino temperatures. Such climate-mediated, physiological stresses may compromise host resistance and increase frequency of opportunistic diseases. Where documented, new diseases typically have emerged through host or range shifts of known pathogens. Both climate and human activities may have also accelerated global transport of species, bringing together pathogens and previously unexposed host populations.

ISSN: 0036-8075

Record 45 of 47

Author(s): Folt, CL; Chen, CY; Moore, MV; Burnaford, J

Title: Synergism and antagonism among multiple stressors

Source: LIMNOLOGY AND OCEANOGRAPHY, 44 (3): 864-877 Part 2 MAY 1999

Abstract: This study was designed to test for synergism (increased stress) or antagonism (decreased stress) among multiple environmental stressors using additive, multiplicative, and simple comparative effects models. Model predictions were compared to empirical results of laboratory experiments measuring interactions among thermal stress, toxin exposure, and low food on reproduction and survival of two species of cladoceran zooplankton. Stress was defined operationally as a reduction in reproduction or survival relative to optimal conditions over a 7-d period. These experiments are particularly applicable to episodic stresses such as those associated with short-term heat waves. Toxin or low food in combination with 30 degrees C temperatures were generally more harmful than high temperature alone. However, most multiple stress effects were antagonistic, in that effects in combination were not as severe as predicted based on the sum or the product of their individual effects. In rare cases, interaction among stressors even diminished effects of the worst single stressor. Optimal conditions for reproduction and survival occurred at 25 degrees C, high food and 0 mg liter(-1) toxin (a surfactant, sodium dodecyl sulfate). Suppressive effects of stressors examined individually ranked: high temperature (30 degrees C) > SDS (10 mg liter(-1) greater than or equal to low food (similar to 100 mu g C liter(-1)) > low temperature (20 degrees C). Daphnia pulex isolated from a pond which experiences high summer temperatures throughout was more tolerant of 30 degrees C conditions than Daphnia pulicaria isolated from a lake with a cold-water refuge. Differences were observed in individuals exposed as either adults or as 24-h neonates.

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Record 46 of 47

Author(s): Dukes, JS; Mooney, HA

Title: Does global change increase the success of biological invaders?

Source: TRENDS IN ECOLOGY & EVOLUTION, 14 (4): 135-139 APR 1999

Abstract: Biological invasions are gaining attention as a major threat to biodiversity and an important element of global change. Recent research indicates that other components of global change, such as increases in nitrogen deposition and atmospheric CO2 concentration, favor groups of species that share certain physiological or life history traits. New evidence suggests that many invasive species share traits that will allow them to capitalize on the various elements of global change. Increases in the prevalence of some of these biological invaders would alter basic ecosystem properties in ways that feed back to affect many components of global change.

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Record 47 of 47

Author(s): Paine, RT; Tegner, MJ; Johnson, EA

Title: Compounded perturbations yield ecological surprises

Source: ECOSYSTEMS, 1 (6): 535-545 NOV-DEC 1998

Abstract: All species have evolved in the presence of disturbance, and thus are in a sense matched to the recurrence pattern of the perturbations. Consequently, disturbances within the typical range, even at the extreme of that range as defined by large, infrequent disturbances (LIDs), usually result in little long-term change to the system's fundamental character. We argue that more serious ecological consequences result from compounded perturbations within the normative recovery time of the community in question. We consider both physically based disturbance (for example, storm, volcanic eruption, and forest fire) and biologically based disturbance of populations, such as overharvesting, invasion, and disease, and their interactions. Dispersal capability and measures of generation time or age to first reproduction of the species of interest seem to be the important metrics for scaling the size and frequency of disturbances among different types of ecosystems. We develop six scenarios that describe communities that have been subjected to multiple perturbations, either simultaneously or at a rate faster than the rate of recovery, and appear to have entered new domains or "ecological surprises." In some cases, three or more disturbances seem to have been required to initiate the changed state. We argue that in a world of ever-more-pervasive anthropogenic impacts on natural communities coupled with the increasing certainty of global change, compounded perturbations and ecological surprises will become more common. Understanding these ecological synergisms will be basic to environmental management decisions of the 21st century.

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